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(54) **Image processing apparatus and method.**

(57) The invention is intended to prevent deterioration in image quality of an image comprising a mixture of a natural image area, a color character image area, etc. in a process of ADCT multi-value color image compression. In the ADCT process, input image data is separated in units of different image areas based on DCT coefficients after DCT. A quantization factor and a quantization table dedicated for natural images are used for the natural image area. For the color character image area, any suitable one of several quantization factors is selected depending on magnitude of an absolute value of the DCT coefficient, and a quantization table dedicated for character is used for quantization. With this arrangement, deterioration of the color character image, particularly, difference in deterioration of characters between different colors, can be prevented.

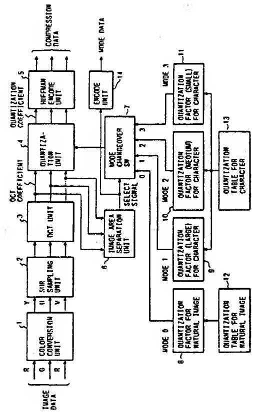

FIG. 1

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an image processing method and apparatus for compressing image data in an adaptive manner to an input image.

Related Background Art

As one of techniques for compressing multi-value images, there has been proposed an ADCT (Adaptive Discrete Cosine Transform) compression method mainly applied to natural images. With this compression method, three primary (RGB) signals are converted into three components of Y, U and V. Of these components, the Y signal representing luminance is compressed at the same resolution, while the U, V signals representing chrominance components are compressed at the lowered resolution after sub sampling. In a step I of the compression, each component is subjected to DCT in units of 8 x 8 pixel blocks for conversion into a frequency space of 8 x 8 to thereby obtain DCT coefficients. In a step 2, quantization tables are respectively prepared for the luminance component (Y) and the chrominance components (U, V) so that the DCT coefficients are linearly quantized (divided) for each component using quantization values of 8 x 8 which are resulted by multi-plying quantization factors by respective elements of the 8 x 8 quantization table, thereby obtaining quantization coefficients. In a step 3, quantization coefficients are subjected to Huffman encoding.

However, when an image comprising a natural image area, a color character image area and a CG image area in a mixed pattem, for example, is compressed by using the prior art compression method as stated above, there has accompanied a sever shortcoming that quality of the color character image and the CG image deteriorates.

Also, it has not been conceived to separately perform quantization of the luminance data and the chrominance data in respective suitable manners.

SUMMARY OF THE INVENTION

An object of the present invention is to solve the problem as set forth above.

Another object of the present invention is to provide an image encoding apparatus which performs encoding in accordance with an original image.

To achieve the above object, according to the present invention, there is provided an image processing apparatus comprising input means for inputting luminance data and chrominance data representing an original; discriminating means for discriminating an image characteristic of the original and outputting a discrimination signal; first quantizing means for quantizing the luminance data; second quantizing means for quantizing the chrominance data; and control means for controlling parameters for said first and second quantizing means in accordance with the discrimination signal of said discriminating means.

Still another object of the present invention is to provide an image encoding apparatus which is highly efficient and highly excellent in quality.

To achieve the above object, according to the present invention, there is provided an image processing apparatus comprising generating means for generating luminance data and chrominance data; first quantizing means for quantizing the luminance data; second quantizing means for quantizing the chrominance data; control means for generating a control signal for said first and second quantizing means; and encoding means for encoding the control signal and outputting an encoded control signal.

Still another object of the present invention is to provide an image encoding apparatus which is simple.

To achieve the above object, according to the present invention, there is provided an image processing apparatus comprising generating means for generating luminance data and chrominance data; discriminating means for discriminating an image characteristic of an image represented by the luminance data and the chrominance data; first quantizing means for quantizing the luminance data; second quantizing means for quantizing the chrominance data; and control means for generating a common controlling signal for said first and second quantizing means in accordance with the discrimination result of said discriminating means.

Still another object of the present invention is to provide an image encoding apparatus which is suitable to process the luminance data and the chrominance data in parallel.

To achieve the above object, according to the present invention, there is provided an image processing apparatus comprising generating means for generating luminance data and chrominance data; first discriminating means for discriminating a characteristic of the luminance data and outputting a first discrimination signal; second discriminating means for discriminating a characteristic of the chrominance data and outputting a sec-

ond discrimination signal; first quantizing means for quantizing the luminance data; second quantizing means for quantizing the chrominance data; and control means for controlling independently said first and second quantizing means in accordance with the first and second discrimination signals respectively.

Other objects and forms of the present invention will be apparent from the following description in conjunction with the drawings and the attached claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. I is a block diagram of an embodiment of the present invention;

Fig. 2 is a block diagram for calculating an image area separation parameter and quantization factors from pre-scan data;

Fig. 3 is a block diagram of another embodiment of the present invention; and

Fig. 4 is a block diagram of a still another embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following embodiments of the present invention, even when an image comprises a mixture of a natural image area, a color character image area and a CG image area, these areas are separated from one another and encoded in respective adaptive manners to prevent deterioration of the color character image, especially eliminate differences in deterioration between different colors, for improving quality of the natural image, the color character image and the CG image.

More specifically, input image data is separated in units of image areas such as a natural image area and a color character image area. A quantization factor and a quantization table dedicated for natural image are assigned to the natural image area. For the color character image area, any suitable one of several quantization factors can be selected depending on magnitude of an absolute value of the DCT coefficient, and a quantization table dedicated for character can be selected. This arrangement makes it possible to prevent deterioration of color characters in an image comprising a natural image area, a color character area, etc. in a mixed pattern, particularly, deterioration in image quality such as differences in deterioration of characters between different colors. The quantization factors and the image area separation parameter are determined by, for example, pre-scanning an image, making a frequency analysis, and calculating values suitable for each image to be processed.

Fig. I shows a first embodiment of the present invention.

Image data of RGB inputted from an image scanner comprising CCDs or a host computer is converted in a color conversion unit I with the following linear matrix conversion formula;

$$\begin{bmatrix} Y \\ U \\ V \end{bmatrix} = \begin{bmatrix} a11 & a12 & a13 \\ a21 & a22 & a23 \\ a31 & a32 & a33 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \qquad \ldots (1.0)$$

into image data of YUV. Y represents an luminance component and U, V represent chrominance components. Considering the fact that human eyes are more sensitive to the luminance component (Y) than to the chrominance components (U, V), the components U, V are sub-sampled in a sub sampling unit 2 for conversion into data with ratio of Y : U : V = 4 : I : I or 4 : 2 : 2. Then, the components Y, U, V are each subjected in a DCT unit 3 to frequency conversion in units of 8 x 8 pixel blocks. Thus-converted coefficients are called DCT coefficients.

An image area separation unit 6 judges whether each 8 x 8 pixel block belongs to a natural image block or a character image block depending on frequency characteristics of three different DCT coefficients for Y, U, V. If it is judged as a natural image block, then a mode 0 is selected by a mode changeover switch 7 using a 2-bit select signal. If it is judged as a character image block, then to which one of modes I, 2 and 3 the block belongs is judged depending on the magnitude of an absolute value of the DCT coefficients and the judged mode is selected in a like manner. In the mode 0, a quantization factor 8 for natural image and a quantization table I2 for natural image are used. In the modes I, 2 and 3, a quantization factor (large) 9 for character, a quantization factor (medium) I0 for character and a quantization factor (small) II for character are used, respectively, along with a quantization table I3 for character.

More specifically, by way of example, the image area separation unit determines the sum S of absolute values of AC components of the spatial frequency conversion coefficients, except DC components, within the

block for each of the components Y, U, V, and compares the magnitude of the sum S with threshold values A, B, C (where A < B < C). It then sets the mode 0 if S < A, the mode I if A ≦ S < B, the mode 2 if B ≦ S < C, and the mode 3 if C ≦ S.

In a quantization unit 4, the components Y, U, V are each quantized per 8 x 8 pixel block by using the quantization factor and the quantization table which correspond to the mode selected by the mode changeover switch 7. At this time, the 2-bit select signal indicating the mode used is encoded in an encode unit I4 into compressed mode data, followed by transmission to the decode side. The mode data is encoded by, for example, entropy encoding such as MH, MR or MMR. As a result, the quantization factor and the quantization table suitable for each of the natural image area and the character image area can be set. For the character image area, in particular, any suitable one of three different quantization factors can be selected depending on the magnitude of an absolute value of the DCT coefficients; i.e., the larger quantization factor is used for the block having the larger absolute value of the DCT coefficients and the smaller quantization factor is used for the block having the smaller absolute value of the DCT coefficients. By so setting, differences in deterioration of characters between different colors can be prevented.

In a Huffman encode unit 5, the quantization coefficients quantized by the quantization unit 4 are subjected to Huffman encoding.

Additionally, the quantization factor 8 for natural image, the quantization factor (large) 9 for character, the quantization factor (medium) I0 for character, the quantization factor (small) II for character, the quantization table I2 for natural image, and the quantization table I3 for character are transmitted to the decode side or stored beforehand in a RAM, ROM, etc. in the decode side.

The compressed data may be expanded in an exactly reversed flow to the above one of signals by omitting the image area separation unit 6. However, the Huffman encode unit 5, the quantization unit 4, the DCT unit 3 and the encode unit I4 are replaced with a Huffman decode unit, a reverse quantization unit, a reverse DCT unit and a decode unit, respectively. The sub sampling unit 2 is required to convert the components in such a manner that with the sub sampling ratio being of 4 : I : I, for example, YI, Y2, Y3, Y4, UI, VI,... become YI, Y2, Y3, Y4, UI, UI, UI, UI, VI, VI, VI, VI,..., or that with the sub sampling ratio being of 4 : 2 : 2, for example, YI, Y2, UI, VI,... become YI, Y2, UI, UI, VI, VI,... The color conversion unit I is only required to perform reverse conversion of the above formula (I.0). The quantization factor 8 for natural image, the quantization factor (large) 9 for character, the quantization factor (medium) I0 for character, the quantization factor (small) II for character, the quantization table I2 for natural image, and the quantization table I3 for character can be used by being transmitted from the compression side. The reverse quantization is performed in the mode selected by the mode changeover switch 7 in response to the select signal obtained by decoding the mode data in the decode unit.

As explained above, by separating an image into different types of image areas and selecting the quantization factor and the quantization table adaptively for each image area, the present invention is effective to prevent deterioration of a color character image and a CG image, particularly, differences in deterioration of color characters between different colors.

While only two kinds of quantization factors for natural image and character are referred in the above embodiment, another quantization factor and quantization table for CG image may be added. Also, while only three kinds of quantization factors for character, i.e., large, medium and small, are employed in the above, the number of quantization factors for character may be four, five or more.

Further, although the select signal is encoded in the encode unit I4, it may be directly transmitted as the mode data to the expansion side without being encoded.

In the above embodiment, the quantization factors, the quantization tables and the image area separation unit 6 are prepared as having default values. However, since their optimum parameters are different per image, optimum values may be calculated by employing a system shown in a block diagram of Fig. 2 for use in the above apparatus. Fig. 2 will be explained below. Image data obtained by pre-scan is subjected to frequency conversion through the same color conversion unit I, sub sampling unit 2 and DCT unit 3 as those in Fig. I. The resultant DCT coefficients are analyzed by a frequency characteristic analysis unit I5, and the analyzed results are inputted to both an image area separation parameter calculation unit I6 and a quantization factor calculation unit I7 where an image area separation parameter, a quantization factor for natural image, and quantization factors (large, medium, small) for character are calculated. Here, the term "image area separation parameter" means a parameter necessary for separation into image areas. The encoded data are stored in a memory and then transmitted via a public line or decoded for display on a monitor to obtain a hard copy by a laser printer or a bubble jet printer (using a head disclosed in U.S. Patent No. 4,723,I29).

Fig. 3 shows a modification of the above embodiment. Components having similar functions as those in Fig. I are denoted by the same reference numerals and will not be described here.

In Fig. 3, the image area separation unit 6 selects any suitable one of modes 0 to 4 in accordance with only the Y (luminance) data Y. Quantization factors for the U, V data are selected in match with the mode signal

for the Y data of the same block. This is based on the fact that image features are likely to be extracted from the luminance component, and enables simplification of the circuit configuration.

In another embodiment of fig. 4, the DCT unit 3, the quantization unit 4, the Huffman encode unit 5 and a quantization table control unit 2l are provided for each of Y, U, V independently so as to permit parallel processing of those component signals. The quantization control unit 2l comprises the image area separation unit 6, the mode changeover switch 7, the quantization factor generators 8 to ll, the quantization tables l2, l3, and the encode unit l4 shown in Fig. l

Encoded data Yl, Y2, Ul, U2, Vl, V2 resulted by encoding the components Y, U, V in parallel are stored in a transmission unit 20 and then transmitted therefrom per block in the order of Yl, Y2, Ul, U2, Vl, V2, for example. The order of transmission may be the frame sequential order of Y, U, V.

According to the present invention, as described above, it is possible to prevent deterioration of an image in the process of compressing the image.

It should be understood that the present invention is not limited to the embodiments as set forth above and may be variously changed and modified within the scope of the invention defined in the attached claims.

Claims

1. An image processing apparatus comprising:
   input means for inputting luminance data and chrominance data representing an original;
   discriminating means for discriminating an image characteristic of the original and outputting a discrimination signal;
   first quantizing means for quantizing the luminance data;
   second quantizing means for quantizing the chrominance data;
   control means for controlling parameters for said first and second quantizing means in accordance with the discrimination signal of said discriminating means.

2. An image processing apparatus according to claim 1, wherein said discriminating means discriminates whether said image characteristic is a line image or not.

3. An image processing apparatus according to claim 1, wherein said first and second quantizing means quantize the data for each predetermined block.

4. An image processing apparatus according to claim 1, further comprising encoding means for encoding parameters controlled by said control means.

5. An image processing method comprising steps of:
   input step of inputting luminance data and chrominance data representing an original;
   discriminating step of discriminating an image characteristic of the original and outputting a discrimination signal;
   first quantizing step of quantizing the luminance data;
   second quantizing step of quantizing the chrominance data;
   control step of controlling parameters for said first and second quantizing means in accordance with the discrimination signal of said discriminating step.

6. An image processing apparatus comprising:
   generating means for generating luminance data and chrominance data;
   first quantizing means for quantizing the luminance data;
   second quantizing means for quantizing the chrominance data;
   control means for generating a control signal for said first and second quantizing means;
   encoding means for encoding the control signal and outputting an encoded control signal.

7. An image processing apparatus according to claim 6, further comprising discriminating means for discriminating a line image portion of an image represented by the luminance data and the chrominance data, wherein said control means performs controlling in accordance with the discrimination result of said discriminating means.

8. An image processing apparatus according to claim 6, wherein said encoding means performs entropy encoding.

9. An image processing apparatus according to claim 6, wherein said first and second quantizing means quantize the data for each predetermined block.

10. An image processing method comprising steps of:
generating step of generating luminance data and chrominance data;
first quantizing step of quantizing the luminance data;
second quantizing step of quantizing the chrominance data;
control step of generating a control signal for said first and second quantizing steps;
encoding step of encoding the control signal and outputting an encoded control signal.

11. An image processing apparatus comprising:
generating means for generating luminance data and chrominance data;
discriminating means for discriminating an image characteristic of an image represented by the luminance data and the chrominance data;
first quantizing means for quantizing the luminance data;
second quantizing means for quantizing the chrominance data;
control means for generating a common controlling signal for said first and second quantizing means in accordance with the discrimination result of said discriminating means.

12. An image processing apparatus according to claim 11, wherein said first and second quantizing means quantize the data for each predetermined block.

13. An image processing apparatus according to claim 11, further comprising discriminating means for discriminating a line image portion of an image represented by the luminance data and the chrominance data, wherein said control means performs controlling in accordance with the discrimination result of said discriminating means.

14. An image processing method comprising steps of:
generating step of generating luminance data and chrominance data;
discriminating step of discriminating an image characteristic of an image represented by the luminance data and the chrominance data;
first quantizing step of quantizing the luminance data;
second quantizing step of quantizing the chrominance data;
control step of generating a common controlling signal for said first and second quantizing steps in accordance with the discrimination result of said discriminating step.

15. An image processing apparatus comprising:
generating means for generating luminance data and chrominance data;
first discriminating means for discriminating a characteristic of the luminance data and outputting a first discrimination signal;
second discriminating means for discriminating a characteristic of the chrominance data and outputting a second discrimination signal;
first quantizing means for quantizing the luminance data;
second quantizing means for quantizing the chrominance data;
control means for controlling independently said first and second quantizing means in accordance with the first and second discrimination signals respectively.

16. An image processing apparatus according to claim 15, wherein said first and second quantizing means quantize the data for each predetermined block.

17. An image processing method comprising steps of:
generating step of generating luminance data and chrominance data;
first discriminating step of discriminating a characteristic of the luminance data and outputting a first discrimination signal;
second discriminating step of discriminating a characteristic of the chrominance data and outputting a second discrimination signal;
first quantizing step of quantizing the luminance data;
second quantizing step of quantizing the chrominance data;
control step of controlling independently said first and second quantizing steps in accordance with

the first and second discrimination signals respectively.

18. A method or apparatus for compressing video data characterised by;
determining the nature of said video data and
adjusting compression parameters in response to said determination.

19. A method or apparatus according to claim 18, wherein the nature of the video data is determined to distinguish natural image data from synthesised image data.

FIG. 1

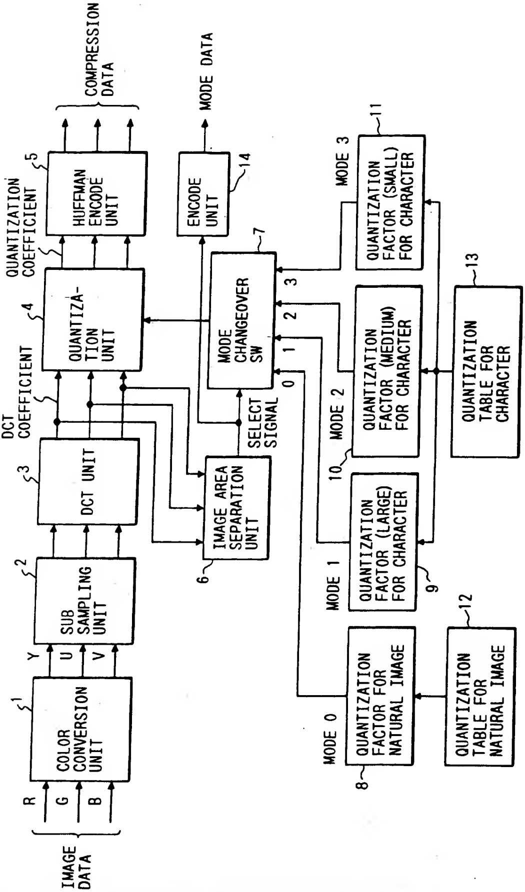


IMAGE DATA
R
G
B
COLOR CONVERSION UNIT
1
Y
U
V
SUB SAMPLING UNIT
2
DCT UNIT
3
DCT COEFFICIENT
QUANTIZA-TION UNIT
4
QUANTIZATION COEFFICIENT
HUFFMAN ENCODE UNIT
5
COMPRESSION DATA
IMAGE AREA SEPARATION UNIT
6
SELECT SIGNAL
MODE CHANGEOVER SW
7
0
1
2
3
ENCODE UNIT
14
MODE DATA
MODE 0
QUANTIZATION FACTOR FOR NATURAL IMAGE
8
MODE 1
QUANTIZATION FACTOR (LARGE) FOR CHARACTER
9
MODE 2
QUANTIZATION FACTOR (MEDIUM) FOR CHARACTER
10
MODE 3
QUANTIZATION FACTOR (SMALL) FOR CHARACTER
11
QUANTIZATION TABLE FOR NATURAL IMAGE
12
QUANTIZATION TABLE FOR CHARACTER
13

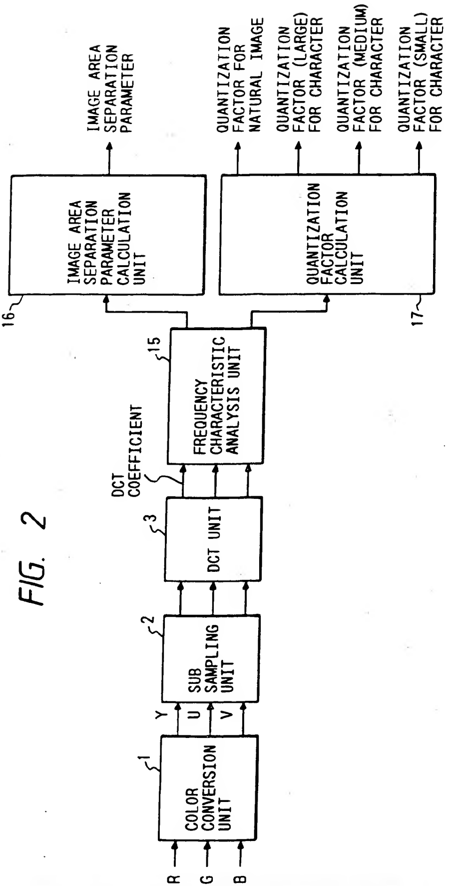


IMAGE AREA SEPARATION PARAMETER
QUANTIZATION FACTOR FOR NATURAL IMAGE
QUANTIZATION FACTOR (LARGE) FOR CHARACTER
QUANTIZATION FACTOR (MEDIUM) FOR CHARACTER
QUANTIZATION FACTOR (SMALL) FOR CHARACTER
IMAGE AREA SEPARATION PARAMETER CALCULATION UNIT
QUANTIZATION FACTOR CALCULATION UNIT
16
17
15
FREQUENCY CHARACTERISTIC ANALYSIS UNIT
DCT COEFFICIENT
3
DCT UNIT
2
SUB SAMPLING UNIT
Y
U
V
1
COLOR CONVERSION UNIT
R
G
B

FIG. 2

FIG. 3

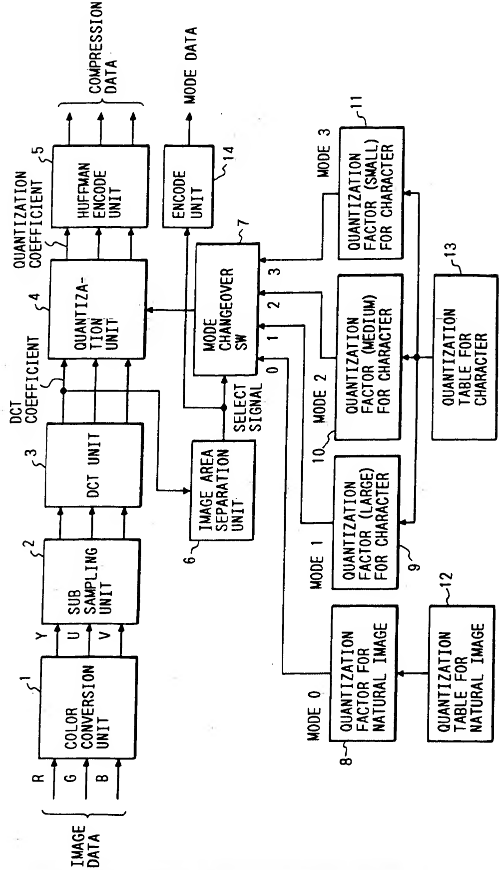


IMAGE DATA
R
G
B
COLOR CONVERSION UNIT
1
Y
U
V
SUB SAMPLING UNIT
2
DCT UNIT
3
DCT COEFFICIENT
QUANTIZATION UNIT
4
QUANTIZATION COEFFICIENT
HUFFMAN ENCODE UNIT
5
COMPRESSION DATA
IMAGE AREA SEPARATION UNIT
6
SELECT SIGNAL
MODE CHANGEOVER SW
7
0
1
2
3
ENCODE UNIT
14
MODE DATA
MODE 0
QUANTIZATION FACTOR FOR NATURAL IMAGE
8
MODE 1
QUANTIZATION FACTOR (LARGE) FOR CHARACTER
9
MODE 2
QUANTIZATION FACTOR (MEDIUM) FOR CHARACTER
10
MODE 3
QUANTIZATION FACTOR (SMALL) FOR CHARACTER
11
QUANTIZATION TABLE FOR NATURAL IMAGE
12
QUANTIZATION TABLE FOR CHARACTER
13

FIG. 4

FIG. 4A
FIG. 4B

FIG. 4A

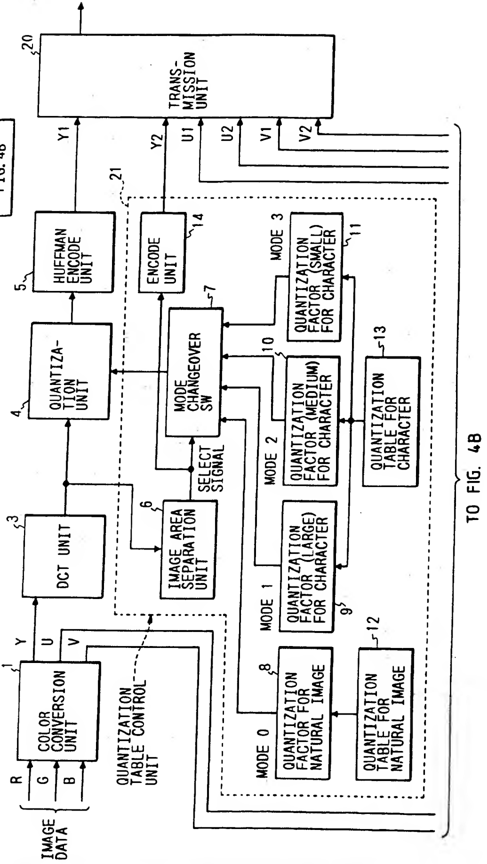
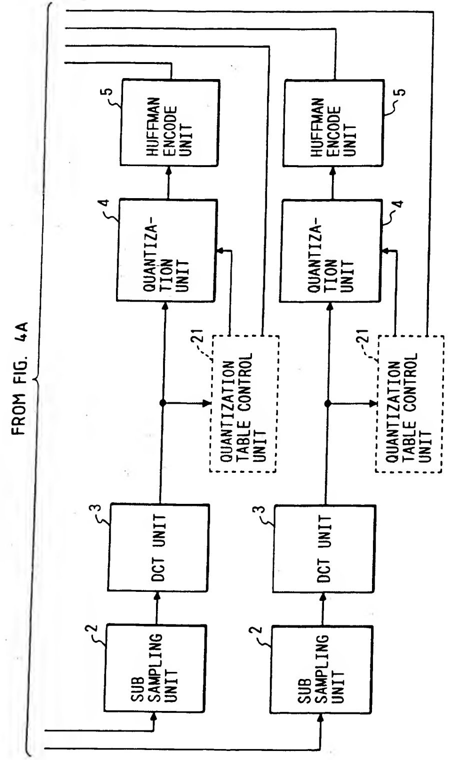


FIG. 4B


FROM FIG. 4A
SUB SAMPLING UNIT
2
DCT UNIT
3
QUANTIZATION TABLE CONTROL UNIT
21
QUANTIZA-TION UNIT
4
HUFFMAN ENCODE UNIT
5
SUB SAMPLING UNIT
2
DCT UNIT
3
QUANTIZATION TABLE CONTROL UNIT
21
QUANTIZA-TION UNIT
4
HUFFMAN ENCODE UNIT
5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 3588

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	PATENT ABSTRACTS OF JAPAN vol. 014, no. 489 (E-0994)24 October 1990 & JP-A-2 202 270 (KONICA CORP) 10 August 1990	1,3,5, 15-17	H04N1/41 H04N1/46
X		18	
A		2,6,7, 9-14	
	* abstract *		
P,Y	& US-A-5 046 121 (YONEKAWA ET AL.)	1,3,5, 15-17	
P,X	* abstract; figures 1-22 *	18	
P,A		2,6,7, 9-14	

Y	COMPUTER (IEEE COMPUTING FUTURES) vol. 22, no. 11, November 1989, LOS ALAMITOS, CA, US pages 20 - 29; A. C. HUNG: 'IMAGE COMPRESSION: THE EMERGING STANDARD FOR COLOR IMAGES'	1,3,5, 15-17	
A	* page 21, right column, paragraph 2; figures 1-11 * * page 24, left column, paragraph 3 * * page 25, left column, paragraph 3 *	6-12,14	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
	---		H04N
A	US-A-4 447 829 (SCHAYES ET AL.)	1,2-7, 10,11, 13-15,17	
X	* abstract; figures 1-7 *	18,19	

A	EP-A-0 042 981 (SIEMENS AKTIENGESELLSCHAFT)	1,2,4-7, 10,11, 13-15, 17-19	
	* abstract; figures 1-13 * * page 28, line 21 - page 31, line 34 *		

A	US-A-4 353 096 (SAKURAI) * abstract; figures 1-5,8,11,12 * * column 4, line 25 - line 65 *	4,6,10	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	10 AUGUST 1992	KASSOW H.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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